CLAIMS:

1. A seismic data method for recording and processing vibratory source seismic data, the method comprising

applying with a vibratory source system a groundforce signal into earth at a selected location, said groundforce signal including a reference sweep signal and non-linear noise, said reference signal having a temporal duration,

recording with first recording apparatus said groundforce signal,

generating a filter for converting a time derivative of said groundforce signal to a short-duration wavelet,

recording with second recording apparatus at least one reflection signal from a location within the earth of said groundforce signal, and

applying said filter to said at least one reflection signal to refine seismic data represented by said at least one reflection signal producing refined seismic data about the location within the earth.

2. The seismic data method of claim 1 wherein the short duration wavelet has a temporal duration less than the temporal duration of the reference sweep signal.

3. The seismic data method of claim 1 wherein the vibratory source system contacts soil and the seismic data method further comprising

driving the vibratory source system with sufficient peak force so that creation of non-linear noise in the groundforce signal due to non-linearity of the soil and non-linearity in the vibratory source system is enhanced.

4. A seismic data method of claim 1 wherein the reference sweep signal has a bandwidth and the filter has a bandwidth greater than that of the reference sweep signal.

5. The seismic data method of claim 1 wherein the refined seismic data is an improved compressed seismic reflection trace

representative of the location within the earth.

6. The seismic data method of claim 1 wherein

the at least one reflection signal is a plurality of reflection signals, each reflecting from a different location within the earth back to the recording apparatus and the method further comprising

recording with the recording apparatus the plurality of reflection signals, and

applying said filter to each of the plurality of reflection signals.

7. The seismic data method of claim 1 wherein

the at least one reflection signal is a plurality of reflection signals, each reflecting from a different location within the earth back to the recording apparatus, the recording apparatus including a plurality of spaced-apart recording devices each of which receives and records at least one of the plurality of reflection signals, and the method further comprising

recording with the recording apparatus the plurality of reflection signals, and

applying said filter to each of the plurality of reflection signals.

8. The seismic data method of claim 1 wherein the vibratory source system is at earth surface and the second recording apparatus is at earth surface spaced-apart from the vibratory source system.

9. The seismic data system of claim 1 wherein the short-duration wavelet has a bandwidth greater than a bandwidth of the reference sweep signal.

10. The seismic data method of claim 1 wherein the short-duration wavelet is produced by a method from the group consisting of autocorrelation of the reference sweep signal and a method including designing a zero or minimum phase wavelet with a prescribed amplitude spectrum.

11. The seismic data method of claim 10 wherein the short-duration wavelet is a Klauder wavelet.

12. The seismic data method of claim 10 wherein the short-duration wavelet is a minimum phase wavelet.

13. The seismic data method of claim 1 wherein the filter is generated by dividing a Fourier transform of the short-duration wavelet by a Fourier transform of a time derivative of the groundforce signal.

14. The seismic data method of claim 1 wherein the filter is applied to the at least one reflection signal by a circular convolution method.

15. The seismic data method of claim 1 wherein particles at the location within the earth are moved by the groundforce signal, the particles then having a velocity, and the ground force signal reflecting from an earth layer beneath earth surface producing the at least one reflection signal indicative of reflectivity of earth at that earth layer and wherein the second recording apparatus includes transducer apparatus for sensing velocity of soil particles adjacent the second recording apparatus and the soil particles moved by the at least one reflection signal, and the method further comprising

translating with computing apparatus the at least one reflection signal into the seismic data to which the filter is applied.

16. The seismic data method of claim 1 wherein the groundforce signal is measured directly with a force measuring device at the vibratory source system.

17. The seismic data method of claim 1 wherein the vibratory source system includes a reaction mass with an interconnected accelerometer and a baseplate with an interconnected accelerometer and a groundforce signal representation is computed from outputs from the accelerometers.

18. The seismic data method of claim 1 wherein the non-linear noise includes harmonic distortion due to non-linearity in the

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vibratory source system and in contact of the vibratory source system and the soil.

19. The seismic data method of claim 1 wherein the first recording apparatus is adjacent the vibratory source system.

20. The seismic data method of claim 1 wherein the second recording apparatus is adjacent the vibratory source system.

21. The seismic data method of claim 1 wherein the first and second recording apparatus are adjacent the vibratory source system.

22. The seismic data method of claim 1 wherein the first and second recording apparatus are remote from the vibratory source system and the method further comprising

transmitting with first transmitting apparatus a signal representative of the groundforce signal to the first recording apparatus, and

transmitting with second transmitting apparatus a signal representative of the at least one reflection signal to the second recording apparatus.

23. The seismic data method of claim 1 wherein a computer is interconnected with the vibratory source system and with the first and second recording apparatus and the computer computes the short-duration wavelet and generates the filter.

24. The seismic data method of claim 23 wherein the computer applies the filter to the at least one reflection signal.

25. The seismic data method of claim 23 wherein the computer is adjacent the vibratory source system.

26. The seismic data method of claim 23 wherein the computer is remote from the vibratory source system.

27. The seismic data method of claim 1 wherein the first and second recording apparatus are a single recording apparatus.

28. The seismic data method of claim 22 wherein the first and second transmitting apparatus are a single transmitting apparatus in intercommunication with both the vibratory source system and the recording apparatuses.

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29. A seismic data method for recording and processing vibratory source seismic data, the method comprising

applying with a vibratory source system a groundforce signal into earth at a selected location, said groundforce signal including a reference sweep signal and non-linear noise, said reference signal having a temporal duration,

recording with first recording apparatus said groundforce signal,

generating a filter for converting a time derivative of said groundforce signal to a short-duration wavelet,

recording with second recording apparatus at least one reflection signal from a location within the earth of said groundforce signal,

applying said filter to said at least one reflection signal to refine seismic data represented by said at least one reflection signal producing refined seismic data about the location within the earth,

wherein $F(\omega)$ is a function of the filter and

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$$F(\omega) = \frac{W(\omega)}{\dot{G}_F(\omega)}$$

where

$F(\omega)$ = Fourier transform of the filter

$W(\omega)$ = Fourier transform of the wavelet

$G_F(\omega)$ = Fourier transform of the groundforce signal

the filter applied to the seismic data, $D(\omega)$, as $F(\omega)\cdot D(\omega)$

where

$$D(\omega) = \dot{G}_F(\omega)\cdot R_E(\omega)\cdot M_E(\omega)$$

where

G_F groundforce

G_M measured groundforce

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D measured seismic data

R_E earth reflectivity sequence

W desired wavelet

M_E earth filter (e.g. a Q-filter)

and the refined seismic data is T:

$$\frac{W(\omega)}{G_F^{*}(\omega)} \cdot G_F^{*}(\omega) \cdot R_E(\omega) \cdot M_E(\omega) =$$

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$$R_E(\omega) \cdot M_E(\omega) \cdot W(\omega) = D_C(\omega) = T$$

30. A method for making a shaping filter for improving seismic data, the seismic data comprising a reflected signal from earth, the reflected signal comprising the reflection of a noise-containing groundforce signal generated by a vibratory source system, the groundforce signal including a reference sweep signal and non-linear noise, the reference sweep signal having a temporal duration, the method comprising

producing a short-duration wavelet with a temporal duration less than that of the reference sweep signal, and

generating the filter by dividing a Fourier transform of the short-duration wavelet by a Fourier transform of a time derivative of the groundforce signal.

31. The method of claim 30 wherein $F(\omega)$ is a function of the filter and the filter is computed as

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$$F(\omega) = \frac{W(\omega)}{i\omega G_F}$$

where:

$W(\omega)$ = Fourier transform of the desired, short-duration wavelet

$G_F(\omega)$ = Fourier transform of the recorded force signal output of the vibrator

$F(\omega)$ = Fourier transform of the filter

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$i = \sqrt{-1}; \quad \omega = 2\pi f$

32. A method for making a shaping filter for improving seismic data, the seismic data comprising a reflected signal from earth, the reflected signal comprising the reflection of a noise-containing groundforce signal generated by a vibratory source system, the groundforce signal including a reference sweep signal and non-linear noise, the reference sweep signal having a bandwidth duration, the method comprising

producing a short-duration wavelet with a bandwidth greater than that of the reference sweep signal, and

generating the filter by dividing a Fourier transform of the short-duration wavelet by a Fourier transform of a time derivative of the groundforce signal.

33. The method of claim 32 wherein $F(\omega)$ is a function of the filter and the filter is computed as

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$$F(\omega) = \frac{W(\omega)}{i\omega G_F}$$

where:

$W(\omega)$ = Fourier transform of the desired, short-duration wavelet

$G_F(\omega)$ = Fourier transform of the recorded force signal output of the vibrator

$F(\omega)$ = Fourier transform of the filter

$i = \sqrt{-1}; \quad \omega = 2\pi f$

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